# 5. Using external media: CDs, DVDs and removable USB storage devices

(This section last updated August 2012)

This section of the *Users' Guide* covers usage of portable data storage devices, including compact discs, DVD discs and external USB disk and flash drives, and includes the following major topics:

☞ *Compact discs :*
- playing audio cds and "ripping" (extracting) samples from audio cds into hard disk soundfiles
- recording and copying audio cds
- creating data cd backups

☞ *DVD discs:*
- creating data DVDs
- playing DVD video discs

☞ creating calibration tones

☞ using the ECMC library of sound sources available on audio cds

☞ using flash drives and external USB drives

## 5.1. Audio and data compact discs

Compact discs can be used to record either audio or computer data. The following types of compact disc decks are in widespread use:

1) *Audio cd players*, connected to stereo playback systems, used to play audio compact discs

2) *CD-ROM* drives (now pretty much obsolete) connected to computers are used to extract data from cds onto the computer system, and often to play audio cds through the computer's audio system as well.

3) *CD recorders* (or "burners") are used to record audio samples or digital data to cd discs, and also to copy audio or data files or entire folders from a cd disc onto a system hard drive.

Two types of recordable compact discs are in common use:
☞ *CDR* ("*r*ecordable") discs can only be written once.
☞ *CD-RW* ("*re-w*ritable") discs can be re-used many times — up to a thousand times, according to some specifications — but must be erased (blanked) each time before they can be re-written. One cannot append to a previously written CD-RW disc, unless the disc has not been *finalized* ("closed").

Commercially manufactured cds user lasers to burn tiny pits into the surface of the disc. By contrast, CDR and CDRW do not contain a pitted surface, but rather a very thin coat of dye, that is melted by a laser into light-and-dark patterns that simulate the pitted surfaces of commercially produced discs. Fortunately, most stand-alone CD audio players manufactured within the last few years are able to read CDR discs without problems. CDRW discs, however, cannot be played reliably, or at all, on some stand-alone audio cd decks. To be safe, always record audio cds to CDR discs. CDRW discs are best suited to data backups, since they can be re-written as a file system changes.

Computer system CD-ROM, CDR and CDRW devices can be either *internal* (housed within the computer tower or laptop enclosure) or, less often, *external* (contained within an external enclosure attached by a cable to an IDE/ATAPI, SCSI or, more recently, SATA port on the computer). However, the software that controls cd recorders usually employs SCSI emulation, "tricking" the operating system into thinking that an IDE or SATA device is a SCSI device. SCSI subsystems offer faster speed and more reliable I/O than IDE.

*Audio cds*

Audio cds are written according to a *Red Book* standard as 44.1 kHz 16 bit stereo samples in a special format called *CDR*. The disc is divided into tracks and sectors, where each sector includes 2352 bytes, equal to 1/75 second of sound. Each soundfile is written to a separate track, which may be up to 1 second longer than the source soundfile, since the final sector is padded with zeros until it reaches 2352 bytes.

Most often, each track is preceded by a silent two second *pre-gap*, and the first track actually begins at absolute time 2 seconds rather than at 0 seconds. There can be up to 99 tracks on a cd, and each track must be at least four seconds long. Most cds hold up to 74 minutes of audio, although 80 minute discs also are available. A table-of-contents near the beginning of the cd holds information about track durations and the layout of the disc, and may include text data (identifying title, composer, performer(s) and similar information). In normal playback mode, the data from an audio cd is read at a rate of about 172 kB per second.

Standalone audio cd decks include fairly sophisticated error correction circuitry that enables the deck to "calculate" (through interpolation) short segments of samples that cannot be read successfully from the disc, even after oversampling re-tries. Many stand-alone audio cd players also employ a (widely misunderstood) technique called *oversampling*, which is <u>not</u> a form of error correction, but rather a technique of raising the playback sampling rate by interpolating between adjacent samples written on the disc. This enables the manufacturer to use a low pass filter with a much gentler slope, and to begin the filtering at a higher frequency.[1] In some cases the resulting audio will sound "smoother" or "airier."

The software cd player applications available on computer systems typically include less sophisticated error correction capabilities, or (more often) none at all. Thus, a disc that seems to play fine on your home stereo system may produces glitches when played on a computer system. Such problems may lie on the disc (e.g. a scratch, or a bad sector), or in the hardware or software of the computer system (buffering problems, interrupts, a bad cable, etc.). If the garbage occurs at exactly the same spots on successive plays, the problem most likely lies on the disc, but these imperfections still may be inaudible on playback decks with error-correction. Software cd applications rarely include oversampling procedures, and do not always employ high quality smoothing filter algorithms. Thus, an audio cd may sound "harsher" when played back on a computer system than when played on a high quality audio cd or dvd player.

*Data cds*

Recordable compact discs also can be used to back up all types of hard disk files (soundfiles, ascii files, image files etc.) and to archive complete directories of files. Files saved to a data cd then can be restored or copied to another computer system at any time. The storage capacity of most cds is 650 MB, of which about 620 MB of space is available to the user. (A small portion of the disc is lost to formatting and filesystem information.) 800 MB discs also are available, but not all cd burning programs recognize or support this larger capacity.

Unlike audio cds, a *CDR* or *CDRW* disc used for data backup most often is formatted according to a cross-platform file system called *ISO-9660*, which can be written and read by Macintosh, Windows and Linux systems. Thus, data discs created with any operating system and be read by any other operating system. On data cds, all of the files usually are written within a single, continuous track, rather than in a one-file-per-track format as on audio cds. The basic *ISO-9660* filesystem employs the irksome 8+3 *DOS* limitation in the length of the names of files and directories to be burned on the cd. However, on Unix/Linux systems the *Rock Ridge* extension system, which customarily is added to the ISO standard, allows long file/directory names and saves file permissions. On Windows systems, the Microsoft Joliet extensions allow long file names. Rock Ridge and Joliet extensions both can be included on a disc.

Compact disc decks, and the (CDR and CD-RW) discs themselves, are rated for the speed at which they can transfer data. The speed rating is a multiple of 150 kB per second, the data transfer rate of the earliest cd-rom decks. Most current cd-rom decks can read data into the computer at somewhere between 40 and 60 times this benchmark. CDR decks have two speed ratings. The first number is a write speed, and the second number is a read speed. Typical write speeds today are between 16 and 52 times the 150 kB/sec benchmark. CD-RW decks have three speed ratings — the first for writing CDR discs, the second for writing to CD-RW discs, and the third for reading discs. Typical write speeds for CD-RW discs are between 4 and 24 times the benchmark figure.

To achieve the maximum CDR or CD-RW write speed of which a deck is capable, however, one must use discs rated for this speed. CDR discs manufactured more than a year or two ago, and some cheaper current discs, have maximum write speeds much lower than the speeds supported by current drives, and cheaper CD-RW discs often have a speed rating of 4x. CD burners and their software drivers read a disc

---

[1] For more technical information on oversampling see *http://www.earlevel.com/Digital%20Audio/Oversampling.html*

label to determine its maximum speed and adjust the write speed accordingly.

Data CDs contain a file system, which must be *mounted* ("attached" to the existing file system) before it can be accessed, and then *unmounted* before the disc can be ejected. By default, Windows and Macintosh systems, and most Linux distributions (currently including *madking*) employ *autopolling* to handle these tasks automatically. System software examines the cd/dvd device frequently to see if a disc has been inserted or ejected, and to determine whether a the data on a newly detected disc is organized according to a recognizable file system format. If so, the disc is mounted and a browser window opens to display its contents, indicating that the disc is ready for use. When cd polling software is running, ejecting a disc automatically *unmounts* the disc, so that the operating system can maintain an accurate, updated listing of all files currently accessible on the system. On *madking* you can unmount a cd or dvd disc by typing

*eject*

in a shell window, or else by pushing the ⬛Eject button on the caddy of the dvd/cd drive on the case of the computer. Before unmounting a disc, however, you should quit any applications that are accessing files on the disc (except for the browser window for the disc). Usually the operating system will prevent you from ejecting the disc while it is still being accessed by some application.

Autopolling is convenient for the user, but it does add to system overhead, thus degrading system performance somewhat, and for this reason it is turned off by some system administrators and in some Linux distributions. Manual mounting and unmounting of cd and dvd discs by the user can save machine cycles for more important tasks, but also can be somewhat bothersome for the user.

Audio cds do not need to be mounted or unmounted, since they do not contain a file system. Likewise, blank cds, or cdrw discs that you wish to overwrite, do not need to be mounted before you can burn data to them, since the disc does not need to be read.

When a previously created data cd or dvd is inserted in a dvd/cd drive, it is attached to the file system at a *mount point* — a "node," or branch, of the full file system. In Fedora Linux distributions, the mount point for external storage devices such as compact discs, dvds and removable disk drives is */media*. Data compact discs and dvds also have a label name, either supplied by a manufacturer (for commercial cds) or by a user when (s)he burned the disc, or else by the disc burning application. To find out the label name of a disc after it has been mounted, type the command

*df -h*

in a shell window. This will display a list of currently mounted disk partitions, additional system file systems and external storage devices, along with information on the size and available free space for each entry. Near the bottom of this list you should find an entry for the data cd that looks something like this:

| Filesystem | Size | Used | Avail | Use% | Mounted on |
|---|---|---|---|---|---|
| /dev/scd0 | 169M | 169M | 0 | 100% | /media/K3b data project |

In this example, the full mount point for the data cd is *K3b data project*. The unwieldy disc name *K3b data project* is the default disc name provided by the cd/dvd burning application *k3b*, and it appears as well in the titlebar of the browser window for the disc.

Once a data cd has been mounted, you can copy files from the disc onto system hard disks by dragging icons from the cd browser window into browser windows for your Unix or soundfile directories. Alternatively, you can use standard Unix commands such as *ls* and *cp* in a shell window to perform these operations. Since the repugnant disc name *K3b data project* includes two spaces, the full mount point must be enclosed in double quotes on the second line below.

| | |
|---|---|
| *df* | [find out the path to and name of the disc] |
| *pushd "/media/K3b data project"* | ["move yourself" onto the cd; make it your current working Unix directory] |
| *ls* | [list the folders and files on the cd] |
| *cp riffs1 riffs2 ˜/Project* | copy files *riffs1* and *riffs2* to your Unix folder *Project*] |
| *mv Sounds* | ["go into" the folder *Sounds* on the cd] |
| *cp \* $SFDIR* | [copy all soundfiles in the cd *Sounds* folder to your current working soundfile directory] |
| *popd* | [return to the Unix directory in which you were working before you "moved yourself" to the cd; be sure to "move yourself" out of the cd before you eject it] |
| *eject* | [unmount the cd and eject it from the disc caddy on *madking*] |

———————————————————————————

### 5.2.  Playing and ripping audio cds

On Windows machines the application *Windows Media Player* generally is used to play audio cds loaded into a system cd drive. On Macs, the *iTunes* application generally is employed for this purpose.  On Linux systems, there are several graphical audio player applications, such as *Audacious*, *Gnome M-Player*, *Rhythmbox* and *Amarok*, that are capable of playing audio cds. These applications can be opened by selecting *Applications->Sound and video* on the taskbar. Many of these media player applications can also play WAVE, MP3, ogg vorbis and other soundfile formats as well.[2] However, these applications can be slow to open and in certain cases require that the user configure or specify the location of the cd device.

Because we have not been fully satisfied with any of these graphical Linux cd playing utilities, we have incorporated a much quicker method for playing audio cds within the all-purpose ECMC **play** command, which can be used at any time, whether or not *jack* is running.  When using the *play* command, specify consecutive tracks to be played from a cd by enclosing the track span in underscore characters.

| | |
|---|---|
| *play _2_* | will play track 2 of the cd |
| *play _4-6_* | will play tracks 4, 5 and 6 |
| *play _9_ ; play _7_ ; play _9_* | will play track 9, then track 7, then track 9 again |

For more information and examples see the *man* page for the *play* command.
To list the contents of an audio cd, you can use the command   *cdrip* -Q  (discussed below).

Perhaps the only occasions on which you will wish to use one of the (comparatively slow) GUI cd playing applications, rather than the ECMC *play* command, is if you want to be able to skip around (fast forward and reverse) while playing a cd audio track.  If *jack* is not running, you can use a simple but functional application such as *Audacious* or *Rhythmbox* by

<p align="center"><em>audacious &</em>    or    <em>rhythmbox &</em></p>

in a shell window, or else  by selecting *Applications->Sound and Video->Audacious* or *Rhythmxbox* from the taskbar.  To access the cd drive  right click in the upper half of the *Audacious* window, then highlight *Playback* and then select *Play CD*.  If *jack* is running, you can use the *audacious* plugin to *jack* (if this plugin has been installed, as it should be on *madking*. After opening *Audacious*, select *Preferences* under the *File* menu and set the output to *Jack*.

———————————————————————

On *madking*, compact disc **ripping**  is accomplished more easily and quickly with shell commands rather than with graphical applications and utilities.  Two full-featured Linux command line rippers come bundled with almost all Linux distributions: *cdda2wav* and the strangely named *cdparanoia*. Both are powerful but, because of their many options, complicated to use.  *cdparanoia* offers better jitter and error correction and is *slightly* easier to use.  Owing to the frequent syntactical complexity of these two programs, several graphical applications have been created to run on top of *cdparanoia* and/or *cdda2wav* in order to hide the "ugliness" of these programs from the user.  However, the current crop of Linux GUI rippers — especially the ripping procedures in the *k3b* application —  are poorly suited to the needs of most ECMC users and are clumsy for our purposes. These GUIs are optimized for ripping songs from commercial pop cds, downloading title/artist information on these tracks from an internet *cddb* database (such as *freedb.freedb.org*) and then encoding them into *mp3* or *ogg vorbis* files.

———————————

[2] *Rhythmbox*, however, is best suited for playing podcasts, internet radio stations and *mp3* files.

To simplify the extraction of samples from audio cds, therefore, we have created an ECMC shell alias command called **cdrip**, which runs *cdparanoia* with the flag options necessary to copy the samples into a *WAVE* soundfile on *madking*'s *snd* disk. The simplest usage of *cdrip* is to print the table of contents on an audio cd, by typing:

<p style="text-align:center">*cdrip -Q*</p>

The resulting display will look something like this:

| Table of contents (audio tracks only): | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| track | | length | | begin | | copy | pre | ch |
| 1. | 14582 | [03:14.32] | 0 | [00:00.00] | | no | no | 2 |
| 2. | 13665 | [03:02.15] | 14582 | [03:14.32] | | no | no | 2 |
| 3. | 12580 | [02:47.55] | 28247 | [06:16.47] | | no | no | 2 |
| 4. | 13910 | [03:05.35] | 40827 | [09:04.27] | | no | no | 2 |
| ----- (several lines for additional tracks omitted here) ----- | | | | | | | | |
| TOTAL | 350270 | [77:50.20] | | (audio only) | | | | |

The length of each track is displayed within square brackets in the third column (e.g. [03:14.32]) and the total length of the disc is shown at the bottom of this column ( [77:50.20] in this case — a long disc!). The starting time on the disc for each track is displayed within square brackets in the fifth column (e.g. [00:00.00]). If the track has been copy protected, so that it cannot be extracted or copied, a "yes" will appear in the *copy* (sixth) column.

The square bracketed *length* and "*begin* time" values require some explanation, since they do <u>not</u> , as one might presume, indicate actual temporal durations. Audio compact discs are written in units called *sectors*, with 75 sectors equaling one second of music. Thus 25 sectors equals a duration of 1/3 of a second, and 37 sectors corresponds to a duration of approximately (but not exactly) 1/2 of a second. The values in square brackets are displayed in

<p style="text-align:center">*minutes***:***seconds***.***sectors*</p>

Note that the sectors field, which specifies values smaller than one second, is preceded by a period rather than by a dot. Thus, the value [03:14.32] indicates a length of 3 minutes 14 seconds and 32 sectors, equivalent to a temporal duration of about 3 minutes and 14.427 seconds.

The syntax for ripping audio with *cdrip* is

<p style="text-align:center">*cdrip  [span]  [outputstring]*</p>

The *span* argument, required unless we want to extract the entire cd, specifies the portion of the cd to be ripped. The optional *outputstring* argument is a character string to be included in the name of the output soundfile(s). If no *outputstring* argument is provided, the default name for the output soundfile will be the track number followed by the string *.cdda.wav*. The *outputstring* argument replaces the *.cdda.wav* extension, and should itself include a *.wav* extension.

In most cases we will want to extract one or more entire tracks from the cd. If we want to use only a portion of a track — say, a 7.33 second excerpt from time 3 seconds into the track to time 10.33 seconds — it is fairly simple to extract the entire track into a soundfile and then use a soundfile editor such as *audacity*, *mhWaveEdit* or *sweep* to crop this soundfile, trimming off segments from the beginning and the end that we do not want.

*Some example cdrip command lines:*

(1) *cdrip 4-5*
Result:  tracks 4 and 5 are ripped from the cd. The output soundfiles are named *track04.cdda.wav* and *track05.cdda.wav*

(2) *cdrip*   (with no arguments)
Result: All tracks on the cd are extracted. The resulting soundfiles are named *track01.cdda.wav*, *track02.cdda.wav* and so on.

(3) *cdrip 6 risset.wav*
Result: track 6 is ripped from the cd. The output soundfile is named *track06.risset.wav*

(4) *cdrip 5 brahms.sym4.mov1.wav ; cdrip 8 brahms.sym4.mov4.wav*

Result: Track 5 is extracted into the soundfile *track05.brahms.sym4.mov1.wav* and then track 8 is extracted into the soundfile *track05.brahms.sym4.mov4.wav*.

It is possible to extract only a portion of a track with *cdparanoia*, and thus with *cdrip*, but the *span* argument quickly becomes fairly complicated: one must include an *skip time* in *seconds* and *sector* field, a hyphen and then an *end* time in seconds and sectors. The following command specifies extraction of an excerpt track one beginning at 5 second 0 sectors into the track and ending at 15 seconds 60 sectors into the track.

*cdrip 1[5.0]-1[15.60] excerpt.movt1.wav*

Result: A 10.81 second excerpt is extracted from the first track, beginning 5 seconds into the track and ending at time 15.81 seconds. (60 sectors = approximately .81 seconds) This excerpt is written to a soundfile named *track01.excerpt.movt1.wav*

While *cdrip* (*cdparanoia*) is extracting it will display diagnostics on its progress. Toward the right edge of the display (but not all the way to the right) *OUTPUT SMILIES* will go whizzing by to indicate how things are going. The symbol you want to see is

**:-)** which indicates smooth extraction with little or no jitter detected.

Some alternative symbols that may indicate trouble, in order of increasing severity, include:

|  |  |
|---|---|
| :-\| | Normal operation, considerable jitter but output probably is okay |
| 8-\| | Finding read problems at same point during reread; errors hard to correct |
| :-( | Scratch detected; output might be okay but might not |
| ;-( | Gave up trying to perform a correction |
| 8-X | Aborted read due to known, uncorrectable error |

—————————————————————————

### 5.3. DVD discs

DVD discs are used in the ECMC studios primarily for backing up data, which may include soundfiles from your *snd* directory and its subdirectories as well as files from your *home* directory and its subdirectories. This will be our principal focus on the following pages.

Occasionally, however, users need to play DVD video discs on ECMC systems. On Windows systems, the default application for playing video DVDs is called *DVD Player*. The default application for playing video DVDs on Macintosh systems has the same name, although it is not the same application. Some Windows and Mac audio applications, such as *Logic* and *Cubase*, also can import digital video from DVDs and other digital sources, and can be used to synchronize video and audio "tracks" and in the creation of multimedia works.

Currently on *madking* there are several applications capable of playing video DVDs. We have had the best results with *Totem Movie Player*. After inserting a video dvd disc into *madking*'s dvd drive caddy, open *Movie Player* by clicking on

*Applications -> Sound & Video -> Movie Player*

To select a video disc in the DVD drive for playing, click on

Movie -> Open -> Play disc 'XXXXX' (where *XXXXX* is the name of the video disc)

and click on Add

Alternatively, click

Movie -> Open ->

and select all of the audio and video files displayed in the right hand column, then click on Add

—————————————————————————

Our focus in the remainder of this subsection will be on creating data DVD discs. All of the four ECMC production systems contain a combination cd/dvd burner and software for burning data dvds. In fact, the procedures for burning dvds often are almost identical to those used in cd creation. As noted earlier in this *Users' Guide*, most DVD discs have a capacity of 4.7 G bytes (about 4.58 Gbytes)[3] and come in several formats:

---
[3] In 2006 dual layer discs were introduced with a capacity of 8.5 Gbytes. However, these larger capacity discs can only be used with recently manufactured dual layer-capable dvd drives.

- *dvd-r* : until about 2005 the most common and portable format; cannot be erased or reused
- *dvd-rw* : a re-writable version of *-r* format, similar to *cdrw* format CD discs
- *dvd+r* : a competing, non-erasable format for long term storage that generally offers faster write speeds (less time to burn a disc); today *+r* format is somewhat more common than *-r* format for data backup purposes
- *dvd+rw* : a re-writable version of *+r* format, generally offering faster burn speeds than *-rw* format

[• *Blu-Ray* is a newer incompatible dvd format for data backup and storing high-resolution video with much higher storage capacities than standard dvds. Blu-ray discs can hold 25 GB of data, 50 GB with dual layer. While currently used primarily with HDTV sets, blu-ray drives also are available for desktop and notebook computer systems as well, but are not yet in widespread use for data backup. As of this writing the burners on ECMC systems cannot write to or read from blu-ray discs.]

Before 2004 most dvd burners supported only *-r/-rw* formats or else *+r/+rw* formats. However, all recent cd/dvd recorders, including the burners in all of the ECMC production machines, can burn to and read from all four of these formats. In addition to these burning capabilities, the *708A* can **read** discs in any of the following formats:

*DVD :* DVD-ROM single layer/dual layer, DVD-R, DVD-RW, DVD+R, DVD+RW

*CD :* CD-DA (Audio CD), CD-R, CD-RW, CD-ROM Mode 1, CD-ROM XA Mode 2, CD-TEXT Read & Write, Photo CD

The current maximum *write and read* speeds for most recently manufactured cd/dvd burners are:

| format | maximum write/read speed |
|--------|--------------------------|
| *DVD-R* | 18x |
| *DVD-RW* | 6x |
| *DVD+R* | 18x |
| *DVD+RW* | 8x |
| *CD-R* | 52x |
| *CD-RW* | 32x |

Naturally you generally will want to burn discs at the maximum possible speed, but remember that to do this you also must use a disc that is rated for this speed or higher. For backing up data onto optical discs, dvd discs generally are preferred over cds because of their much greater capacity and negligable cost differential.

### 5.4. Burning audio and data cds

All of the ECMC production systems include a combination cd/dvd burner by manufacturers such as Plextor and Memorex and (since these recorders have become a commodity item) by no-name manufactures. We periodically upgrade cd/dvd drives on the ECMC systems and swap drives between these systems, so any listing of the models and their speeds and capabilities available on various ECMC computers quickly becomes outdated.

Many newer cd/dvd recorders, like the models in most of the ECMC production machines, incorporate a technology called *Burn-Proof*. The most common causes of "coasters" — cds with glitches that make the disc unusable — are buffer underruns: data is not available to the cd recorder at the instant it is needed. The Burn-Proof technology, sensing an impending buffer underrun, turns off and stops the laser until the buffer is reloaded, then resumes recording with no loss or gap in the data. However, even with this very nice feature, users should remember that cd burning is a real-time process and exercise caution not to overtax a computer system while cd burning is in process. Do not attempt processor-intensive or I/O-intensive tasks, such as deleting large files, or creating soundfiles, while burning a cd. While recording, it is fine to use a text editor, read email or surf the web (so long as you don't cache too many large web pages), but steer clear of applications such as *SuperCollider*, *Csound*, *Pd* and soundfile mixing programs that create a lot of disk input/output.

Windows 7 and 8 systems come with integrated cd/dvd burning software. Inserting a blank dvd or cd into the computer's optical disc caddy will automatically open a "burn disc" window. Select the "*with a CD/DVD player*" option, drag folders and files to be backed up to the disc drive icon, then click on this

icon to begin burning. On ⌈Macinstosh⌋ systems simply inserting a blank cd or dvd disc will open a dialog box that will guide you through disc burning using commands from the *Finder*. Audio cds also can be assembled and burned from within the *iTunes* application.

On ⌈Linux⌋ systems the command line programs *cdrecord* and *cdrdao* are quite powerful, providing a great many options, but for this very reason can be difficult to use, at least initially. Several graphical front-ends have been developed to provide a more intuitive, graphical interface for running *cdrecord* and/or *cdrdao* in the background. The most popular of these GUI burning applications is *K3b*, a fairly robust and easy-to-use applications that includes most or all of the features you likely will need when creating cds and dvds. *K3b* can be used to burn data DVDs as well as audio and data CDs, and also can be used to copy CDs. Thus, by learning this one application, you can apply almost identical procedures to burn both CDs and DVDs. *Brasero* is another popular Linux application, available on *madking*, with capabilities similar to those of *K3b*.

### 5.4.1.  Using K3b to burn cds and dvds

To open *K3b*, type:        *k3b  &*
in a shell window or else click on the *Applications* in the taskbar, then highlight *Sound & Video* and scroll down until you can select *K3b*. The first time you open K3b you should configure it by clicking on *Settings* in the *K3b* Taskbar and then on *Configure K3b*. The default settings should all work fine, but check to make sure that:
   • on the *Misc.* page, *Used audio output system* is set to *alsa*
   • on the *Devices* pages the cd/dvd burner for the system is selected as the *Writer Drive* (this setting should not be blank)
   on the *Advanced* page, *Use Burnfree*, *Do not eject medium after write process* and *Automatically erase CD-RWs and DVD-RWs* should all be checked (unless you want to be prompted before over-writing re-writable discs. Should you prefer, manually erasing re-writable cd discs is as a separate operation is an option provided in the *Tools* menu.)
   • There is one change I recommend, unless you want to hear a repellent sound effect accompanying all K3b error messages: on the *Notifications* page uncheck the box next to "Actions: Play a sound" and, for good measure, click on the *Turn Off All Sounds* button. Then click *Apply* and then *OK*.

When you open *K3b* you will be presented with the main menu, allowing you to choose one of four tasks:
   (1) Burn an audio cd ("New Audio CD Project")
   (2) Burn a data cd ("New Data CD Project")
   (3) Burn a data DVD ("New Data DVD Project")
   (4) Make one or more copies of a cd ("Copy CD")
Choose one of these four options to begin.

*Burning AUDIO cds with K3b*

Selecting *New Audio CD Project* from the main *K3b* menu opens a window with a browser at the top and an *AudioCD1* window at the bottom. Locate the soundfiles you want to burn in the browser. Double click on the *Root* folder in the left pane, then on the *snd* folder and then on your soundfile folder in the right pane. Find the soundfiles your want to burn and drag them into the *Current Projects* window.

Should you want to change the default two second silent gap between tracks, right click on a track and select *Properties*. In the *Audio Track Properties* window that opens, click on *Options* and raise or lower the *Pregap* value. On the same *Properties-->Option* page it is possible to uncheck the *Copy permitted* box, so that no additional copies of this cd track can be made. Generally this is not recommended. Then click on *Apply* and then on *OK*.

As you add soundfiles to the track list *K3b* will update the total program time in the bottom left corner and the available recording time on the disc in the lower right corner. If you want to change the track order, simply drag a track to a new position in the track list.  will indicate the current size of the data to be written to the disc.

2)      When you have included all the soundfiles you wish to burn to the CD, click on the ⌈Burn⌋ icon on the far left just above the track list, or else click the *Project* Taskbar tab and select *Burn*.

3)      In the *Audio Project* window that opens you should not have to change any of the defaults. The speed should be set to *Auto* (*K3b* will choose the highest speed supported by both the CD drive and the disc). Check the *Simulate* box only if you want to do a dry test run before actually burning a disc. *Only create image* should NOT be checked. Click on the ⎡Burn⎤ button and recording should begin.

*Burning data cds and dvds with K3b*

Procedures for burning data cds and data dvds with *K3b* are similar to the steps for burning an audio cds. There is one difference to note between using erasable cds and dvds: unlike cd-rw discs, *re-writable* DVD discs need to be formatted before they can be used. To format a virgin *dvd-rw* or *dvd +rw* disc with *K3b*, select

*Tools -> DVD -> FORMAT DVD +/- RW*

1)      After selecting *New Data CD Project* or *New Data DVD Project* from the main *K3b* menu locate the files and/or complete directories that you want to archive within the browser windows at the top and drag these down to the *Project* window. As you add more files and folders to the *Project* window, the green slider at the bottom will be updated to indicate the total size of the archive to be burned to the disc.

By default, *K3b* will not display your configuration dot files, nor include dot files within directories such as your home Unix directory. If you want to archive preference and configuration files such your *.bashrc*, your *Firefox* bookmarks (in ˜/.mozilla/Firefox/USERID/bookmarks.html) and .ardour2 (your *ardour* preferences), right click on the browser window in *K3b*, select *View* and then select *Show Hidden Files*. (Unfortunately, this must be done every time you want to include hidden files in an archive. There is no way to permanently change *K3b*'s default practice of not displaying these files.) Now, if you drag your entire *home* Unix directory to the *Project* window, your dot files will be included in the archive.

If you prefer, you can drag icons for files to be archived from your Gnome file browser (rather than from *K3b*'s own browser window) into the archive list in the bottom half of the *K3b* window.

2)      Give the disc a name in the *Volume Name* box. Do not include spaces or special characters. In the future, when you mount the disk this name will appear in the titlebar of the disc's browser window.

3)      When all of the files and folders you wish to archive are contained in the *Project* window, click on the *Burn* icon. In *Data Project* window that opens, make sure that the recording *Speed* is set to *Auto*. If you want *K3b* to verify the integrity of the disc after it has been burned, comparing each cd or dvd file byte-by-byte with the original disk version of the file, check the *Verify written data* box as well. This is highly recommended for important discs, but verification may take as long as the burning process itself.
When you are ready, click on the ⎡Burn⎤ button and recording will begin.

Note: Occasionally the erasure of a *cd-rw* disc before re-writing may seem to fail. If this happens, close the *Burn* window and try again.

After burning a CD (or DVD) disc, you should always test that the disc can be read correctly by an audio cd player or, for data discs, by the computer system. To check a data disc immediately after burning, you may need to eject and then reload the disc and then wait a few seconds until the operating system mounts the disc and a browser window for it opens. Display one or two of the ascii files on the data disk and make sure they look correct.

─────────────────────────────────

## 5.5. Creating calibration tones

When you send an electroacoustic composition for inclusion on a concert, it is a good idea to include calibration tones along with the cd or soundfile of your composition. Often, when composers first hear their works played in a large performance space, especially an unfamiliar one, they will be disappointed, and feel that the audio "just doesn't sound quite right." Some of this disappointment is inevitable. While working on the composition in a studio, your ears become very attuned to the acoustical characteristics of the system on which you are assembling the piece, and the room in which you are hearing it. Additionally, amplifiers and loudspeakers must "move a lot more air" in a large concert hall space than in a small studio. There will be more reflections and reverberation, and the large PA speakers that must be used to fill larger spaces

generally will not be as accurate as studio nearfield reference monitors. In larger performing spaces, high frequencies — traveling much further and in a more diffuse space— will decay significantly in amplitude before reaching the listener. The large space also may seem to smear details of the work, such as precise panning locations, particularly if the speakers are widely spaced (as is often necessary). I have seen composers agonize during tech sessions of their works (and exasperate audio engineers), requesting that levels be raised or lowered, futzing interminably over EQ settings, trying this, trying that, and in the end winding up little happier than when the tech session began.

In addition to the unavoidable acoustical and psychoacoustical differences between concert hall and studio playback of a piece, even when high quality equipment is used, however, sometimes there actually are technical problems with a concert hall playback system and/or performance space that may be correctable, at least to some degree, if they can be isolated, accurately identified and then treated. The output channels may not be be matched properly in level. Frequency equalization (EQ) circuits in the playback mixer or elsewhere in the system may not be accurate. There may be hiss or noise in the system, or distortion in one or more frequency bands. But how is one to distinguish with any certainly between correctable problems in the playback system and subjective responses that the piece "just doesn't sound as good as it did in the studio?" The answer is to use calibration tones during the tech session.

Calibration tones typically consist of 1 kHz, 10 kHz and 100 Hz sine tones at a known amplitude level played back on all channels of the reproduction system. These tones are long, typically about 30 seconds each in duration, so that there is sufficient time while they are playing to make adjustments in the playback system and to hear the results of these changes.

An ECMC utility called *mkcaltones* enables you to create a soundfile with calibration tones easily for use in such situations.

<center>*mkcaltones  defaults*</center>

will create a stereo 44.1k 16 bit soundfile with three successive sinusoidal tones, the first at 1 kHz, the second at 10 kHz, and the last at 100 hertz. Each tone will have a duration of 15 seconds, and the tones will be separated by one second of silence. The amplitude level will be -15 dB below maxamp, or a raw integer value of about 5623 on a scale of 0 to 32767. In place of the *defaults* argument above, one can include command line flags and arguments that adjust the sampling rate (to any value up to 96000), the bit depth (16, 24 or 32 bits), the number of channels (1, 2, 4, 5, 6 or 8), the duration (any integer value up to 30 seconds) and the gain (values of -3, -6 or even -1 may be more usable than -15 dB with compact disc, DVD and audio soundfile sources.)

The command

<center>*mkcaltones sr 96000 bits 24 chan 4 gain -3*</center>

will create a calibration tone soundfile at 96 kHz sampling rate, 24 bits, 4 channels and an amplitude of -3 dB relative to maxamp. For more details and examples consult the *mkcaltones man* page.

Note that when you play back these tones on another system, the actual meter levels for the tones may differ from meter readings in room 52, depending upon how much headroom has been calibrated into the playback system gain structure. However, all tones should register at the same level, and remain locked at this level, with no deviations, on all channels.

<center>_____</center>

## 5.6. The ECMC cd library of sound samples

Over the years ECMC staff members have put together a library of acoustic sound source samples that are available to all ECMC users. We recorded some of these samples ourselves (the Eastman vocal and gamelan sample volumes below) and have licensed others from commercial vendors. You are free to use all of these samples in any way you wish in your compositional work in the studios, but legally you are prohibited from redistributing the commercially licensed samples.

As of this writing, our library of acoustic sound samples includes the following cds, most with cd copies:

<div align="center">

1. **BBC** : sound effects: (volumes 11-20)                    1-26

</div>

Consult the *ECMC AUDIO DAT TAPE LIBRARY* binder, available in all three studios, for a complete listing of the contents of all current sample library cds.  Similar information is included in many of the cd jackets.

Over the years we have converted some of the sound sources available on these cds (especially those recorded at Eastman) into *sflib* soundfiles, but more than 80 % of these sounds are available only on cds. To sign out a cd, see a staff member. Only two cds can be signed out at a time, and they must be returned within two days. Be very careful with these cds while they are in your possession. It was tedious to produce some of them, and if you lose or damage one, we will have to charge you a replacement fee.

---

### 5.7.  Using flash drives and external USB drives

Data transfers between optical cd or dvd discs and a computer system are relatively slow, and sometimes are subject to read and write errors and other problems (such as bad discs). During the past several years portable external USB 2[4] storage devices have become a very convenient, efficient and  economical alternative medium for archiving data and for copying data from one computer system to another (including cross platform transfers between Windows, Linux and Macinstosh computers). Popular current USB storage devices include:

---

[4] For the remainder of this discussion *USB* will always refer to *USB 2* rather than the older, much slower *USB 1* format.

• portable external USB hard drives, about the size of an average hard cover book, with capacities between about 250 GB and 2 TB
Portable USB drives are particularly useful for backing up large amounts of data, such as all of the soundfiles used to create one or more electroacoustic compositions, or one or more complete file systems.

• *Flash* drives and similar miniature USB storage devices such as "pen" and "thumb" drives
Lightweight flash drives are about the length and width of a large stick of chewing gum and thus can easily be carried around in a pocket or on a key chain. The drive is enclosed in a plastic or metal case with a USB connector at one end covered by a removable cap. (Be careful. These caps are easily misplaced and lost.) Most current flash drives have a capacity of between 2 and 16 GB and draw their power directly through the USB port on the computer case. Larger flash drives of up to 64 GB  capacity are available, but require a supplemental power source and are considerably more expensive.
Flash drives are ideal for daily backup of ascii and project files and also for soundfiles (so long as the storage requirements of the soundfiles does not exceed the capacity of the drive).

Most USB external and flash drives come pre-formatted with a single Windows *vfat* data partition. (However, the capacity of many *flash* drives is reduced slightly by a small Windows utility partition called U3.) Linux and Mac system can read and write to the *vfat* partition, but if you are certain that you will use the flash drive exclusively on a Mac or on a Linux box you can reformat it (wipe the drive clean of everything, to start over), install a native Mac or Linux filesystem format and/or, if desired, repartition the drive. Reformatting and/or partitioning might seem hardly worth the trouble with a modest capacity flash drive, although it can solve a possible permissions problem discussed later.  However, partitioning often is very useful with large capacity USB external drives.[5]

The procedures for using USB external disks and flash drives are virtually identical.  Either before booting or else while the computer is running, connect the drive to a USB port on the computer case with a USB 2 cable (for external hard drives) or with the USB connector on the flash drive.  Many flash drives will flash blue when they are connected and are receiving power.  External hard drives also need to be powered up.

Windows, Mac and most Linux systems (including *madking*) are configured to continuously poll the USB ports in search of newly connected devices and then to *mount* the device automatically, attaching its folders and files to the current file system.  As soon as the device has been mounted, a desktop window for the storage device usually will open, displaying the contents of the drive and thus indicating that the drive is ready for use.  If you have created several partitions on an external hard drive, several windows will open, one for each partition.  The label of the device or partition will appear in the titlebar of its window.

Some Linux distributions and system administrators prefer to turn off autopolling of USB devices, since this adds to system overhead. In such cases, users must issue commands  to mount the drive and subsequently unmount it when it is no longer needed.

To copy files and complete folders to and from the USB drive you can simply drag icons for these files between the window for the drive and a graphical window for some hard disk folder. You also can delete files on the USB drive, rename them, and perform most any action on these files that can be performed on a hard disk file.

These same operations on external disk files also can be performed, sometimes more quickly or with less fuss, by means of commands issued from a shell window. Before you can issue such commands, however, you must know the name and mount point of the drive.  On *madking* and other Fedora systems external disks and storage devices, as well as cd and dvd disks, are mounted on the file system branch */media*. To find out the name of name and path of a mounted flash drive or of external USB disk partitions after the drive has been mounted, type the command
<div align="center">

*df*  or, to display the data in "human readable" format,  *df -h*
</div>

The output of *df* will provide information on the size, current usage and free space on all currently mounted storage devices. Near the bottom of the *df -h* output you should find a line that looks something like this:

---

[5] A recommended application to use for reformatting and partitioning internal and external drives is *gparted* (Gnome Partition Editor), available in "Live" format for Linux, Macintosh and Windows systems. Mac systems include a good built in application called *Disk Utility*.

Section 5: Using external media: CDs, DVDs and removable USB storage devices

| Filesyste | Size | Used | Avail | Use | Mounted on |
|---|---|---|---|---|---|
| /dev/sdd1 | 2.0G | 1.2 | .8G | 60 | /media/disk |

Here a 2 GB flash disk with .8 GB of usable free space has the generic mount point */media/disk*. Sometimes the manufacturer will give the flash drive a fancier name, such as */media/STORE'N'GO*.  External USB drives will have a *df* entry for each mounted partition.  Now from a shell window we could perform a series of operations like this:

| | |
|---|---|
| *ls -lh /media/disk* | [list the contents of the flash disk] |
| *p /media/disk/mix1.wav* | [play a soundfile stored on the flash disk] |
| *cd /media/disk* | [make the flash drive your current working Unix directory] |
| *ls \*temp\** | [list all files on the flash disk whose names include the character string "temp"] |
| *rm \*temp\** | [remove all of these "temp" files to free up space on the flash drive] |
| *mkdir Section2* | [create a new folder on the flash drive] |
| *cd* | [return to your home Unix directory; be sure to perform this command before disconnecting the flash drive] |
| *lsf* | [list the soundfiles in your current working soundfile directory] |
| *cpsf flute2.wav perc\* /media/disk/Section2* | [copy soundfile *flute2.wav* and all soundfiles whose names begin with the character string "perc" to this new folder on the flash drive] |

If your flash drive has a volume label name that includes 'special" characters (such as one or more spaces,or a  #  or  ' character), enclose the drive name in double quotes, like this:
ls -lh "*/media/STORE'N'GO"*
*p "/media/STORE'N'GO/mix1.wav"*    (and so on)

When you are done using the flash or external disk drive,  do not simply disconnect the drive from the USB port.  First be sure first to quit any applications or windows that may be accessing the drive, then manually unmount the drive from the file system with the shell command

*umount /media/XXX*    (where "XXX" is the name of the USB drive).

Make sure that the USB device has actually been unmounted by issuing another *df* command, checking that */media/XXX* no longer appears.  Then disconnect the flash or USB drive. Manually unmounting external USB and firewire disks before disconnecting them will guard against possible corruption of the file system.

**5.7.1.  Using *rsync* to backup files to external drives**

The Unix command *rsync* provides a convenient, time-saving way to archive all of the files in an important Unix or soundfile directory to directories on an external USB or flash drive and to painlessly update these archive directories.  Recommended usage is:

*rsync  -av  sourcedirectory  targetdirectory*

This will synchronize all of the files in the target directory (on the external USB or flash drive) with those in the source directory, so that the target directory mirrors the source directory, but may also include some older files that have subsequently been deleted from the source directory on a system hard drive. If you issue the alternative command

*rsync  -av --delete sourcedirectory  targetdirectory*

the target directory will be an exact clone of the source directory. Files that currently exist in the target directory, but no longer exist in the source directory, will be deleted from the target directory. See the *rsync man* page for more options.

Example usage of *rsync*:
I am working on an electroacoustic composition. I keep all of the ascii and other source files used to create this composition (e.g. *score11* files, Pd patches and so on) in a Unix directory named *Project* (/home/allan/Project), and I keep all of the soundfiles for this project in an *snd* disk directory also named *Project* (/snd/allan/Project). I have an external USB drive, or a flash drive, with the volume label name */media/disk*. On this external drive I want to create a folder named *Backup*, where I want to back up all of the source files in /home/allan/Project, and another folder on the external drive named *Sounds*, where I want

to archive all of the soundfiles currently in /snd/allan/Project. To accomplish this, I could issue the commands

     *rsync -av  /home/allan/Project/ /media/disk/Backup/*

     *rsync -av  /snd/allan/Project/ /media/disk/Sounds/*
     (where "disk" is the name of the USB or flash drive)

These two commands will copy all of the files in */home/allan/Project/* to */media/disk/Backup/*, and all of the files in */snd/allan/Project/* to */media/disk/Sounds/*.  Note the concluding **/** ("slash") characters at the ends of both the source directories and the target directories. Be sure to include these trailing slash characters at the ends of all source and target directories or *rsync* will not work as you intend.

     Caveat: If your external USB or flash drive is formatted with the default Windows *vfat* format, *rsync* may give you errors such as

     *chgrp "/media/disk/." failed: Operation not permitted*
The *vfat* filesystem has no read-write permissions for "other" users, and thus cannot save these permissions in its version of a file. The actual contents of the files copied, however, should be identical to the original version on the hard disk.

     At the conclusion of my next work session on this project, I could again issues these two *rsync* commands, and the contents of */media/disk/Backup/* and */media/disk/Sounds/* will be updated to include all new files I have created for this project during today's work session.  Files in a source directory that I have edited or otherwise changed will be updated in the archive directory.

If I want to delete files on the external backup drive that no longer exist in the source directories,  so that my archive folders are exact clones of the current source directories, I could include the *--delete* flag option:

     *rsync -av --delete  /home/allan/Project/ /media/disk/Backup/*
     *rsync -av --delete  /snd/allan/Project/ /media/disk/Sounds/*

     If I have a Linux or Macintosh system at home I also can use my external USB or flash drive and *rsync* to create mirrors of some of my important folders on *madking* on my home system.[6]

     Since I will be using these two commands frequently — possibly at the conclusion of every work session on the project — I would like to simplify their execution.  Here are two ways to do this:

☞ Method (1)
     • Create a file with that includes the two *rsync* lines above.  I will name this file  "backupproject."
     • Mark the file executable:    *chmod +x  backupproject*
     • In the future, I need only type   *./backupproject*    to execute these two commands.

If, over time, you create several utility shell scripts like this one, create a subdirectory named *bin* branching from your home folder and place all of your executable scripts in this *bin* folder, which your shell automatically will search when interpreting your commands.  In this case you will only need to type    *backupproject*   to execute the two rsync commands.

☞ Method 2:
I could edit the file *.bashrc* in my home directory and include a (long) line like this:
     *function  backup  {  (  rsync  -av  /home/allan/Project/  /media/disk/Backup/  ;  rsync  -av /snd/allan/Project/ /media/disk/Sounds/) }*

Here again, in the future, I will only need to type    *backupproject*    to execute the two commands.

---

[6] In fact, by using *ssh* and *rsync* in combination, it is possible to mirror folders on two remote systems without the need for a USB external or flash drive.